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TWENTY-FIRST
ANNUAL REPORT
1947

CENTRAL STATES
FOREST EXPERIMENT STATION
Columbus 15, Ohio

Harold L. Mitchell, Director

C O N T E N T S

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INTRODUCTION

During 1947 this Station made steady progress on a forest research program for the Central States region.[1] An analysis of the principal forest research problems in the Illinois Research Center territory was completed. A research program based on this analysis was set up. It was considered and approved by a research advisory council composed of local woodland owners, forest industry operators, representatives of state and federal forestry agencies, and others interested in obtaining maximum production from the forest land of the area. Initial research will be concentrated largely on the Kaskaskia Experimental Forest in southern Illinois. In preparation for this work a road system was planned for the experimental forest, and research areas were laid out on the ground. Boundaries of the experimental forest and individual research areas were marked, and some of the equipment needed for operating a forest property was procured.

Much of the activity of the year at the Ames Research Center in Iowa was centered on selecting and establishing experimental areas on state land, chiefly on the Yellow River State Forest in the northeastern part of the state. Plans were drawn for the development of some 1,900 acres of this property as the Paint Creek Experimental Forest to be operated cooperatively by the State of Iowa and the Central States Forest Experiment Station. This forest area is typical of the "breaks" along the Mississippi River in northeastern Iowa, southeastern Minnesota, and northwestern Illinois. Research compartments will be established to determine the best cutting methods to use in the hardwood stands typical of this area, to ascertain the volume per acre that will provide maximum timber growth, and to estimate the cost and returns of timber-growing operations.

In the field of Forest Economics a technical paper was prepared and issued showing the contribution of farm woodlands to farm income in the corn belt region of Illinois. Final plans were drawn for a study of the cost of producing wood chips for the manufacture of roofing felts and building

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1/ In this report the Central States region includes Iowa, Missouri, Illinois, Indiana, Ohio and Kentucky--the six states served by the Central States Forest Experiment Station.

paper. Field work was undertaken and considerable data on the cost of cutting wood, transporting it to chipping plants, and chipping were obtained.

During the period January through May the Station collected current data on lumber production for the Central States region and in addition for Kansas and Nebraska. This work was discontinued at the end of May because of the termination of cooperative arrangements with the Civilian Production Administration and the Office of the Housing Expeditor.

In the fall of 1947 field work of the Forest Survey was completed in Missouri. By the end of the year field work was well under way in Illinois, and considerable progress had been made on the compilation and office analysis of the field data obtained in Missouri. A sampling study was completed to determine the 1946 production of fuel wood and fence posts in Missouri.

In 1947 a reconnaissance of the areas covered by strip mine operations in this region was completed. By the end of the year drafting work was well along on large-scale maps showing the township, range, and section location of all stripping operations. In addition, research work was begun on how best to establish tree growth on spoils banks.

Silvicultural studies to determine the best methods for increasing the proportion of shortleaf pine in the hardwood stands of the Missouri Ozarks were continued.

Three Norris-Doxey farm forestry research projects were carried on during 1947. Last spring field work on the silvicultural and economic aspects of maple syrup production in Ohio was completed. In Iowa the analysis of the log grade yield information previously obtained in cooperation with the Forestry Section of the Iowa Agricultural Experiment Station was continued. In Illinois a study of the veneer basket and box industry was initiated in cooperation with the Illinois Agricultural Experiment Station.

During 1947 the two representatives of the Forest Utilization Service made 330 visits to forest industry operations in the Central States region for the purpose of advising operators on the technical problems in the manufacture of primary and secondary forest products. In addition they analyzed 1,770 requests for information to the Forest Products Laboratory from persons in the Central States. This analysis indicated the relative importance of the problems confronting the forest-industry operators in this region.

Progress on Station projects during 1947, research results obtained, and plans for 1948 are discussed in detail on the following pages. The discussion is organized by technical divisions of the Station, with separate presentations for the research centers and cooperative forestry projects.

FOREST MANAGEMENT

Progress in the field of Forest Management research will be reported principally under three major subdivisions: (1) Spoil Banks Reclamation, (2) Forest Soils, and (3) Silviculture. In addition, several members of the Management Division contributed substantially to the development of the research programs of the Carbondale and Ames Research Centers. This activity will be treated more fully under the sections of this report dealing with the two research centers (pages 23 to 31). Also the studies on the Kaskaskia Experimental Forest, which were begun prior to the establishment of the Carbondale Research Center, were reviewed on the ground with Center personnel. Agreement was reached on responsibility for further work on them, including the reporting of results.

SPOIL BANKS RECLAMATION

Progress and accomplishments in 1947

The 1947 progress on this project falls into three principal classes: (1) reconnaissance to determine the extent of strip-mined areas and their suitability for planting; (2) planting tests to determine the forestation possibilities on strip-mined lands; (3) development of a classification system for strip-mined land as a guide to forest planting.

The initial reconnaissance of strip-mined areas in the Central States region was completed. The results, shown in Table 1, indicate that nearly 190 thousand acres in nine states have been covered by stripping operations.

Table 1.--Area strip-mined, stripped area forested, and proportion of stripped area suitable for forest growth by states

State	Stripped area	Stripped area forested		Proportion of stripped area suitable for forest growth
		Naturally	Planted	
	Acres	Acres	Acres	Percent
Arkansas	3,170	693	4	100
Illinois	39,820	2,235	9,787	97
Indiana	40,573	1,785	16,996	95
Iowa	2,499	146	16	75
Kansas	25,182	3,346	2,325	98
Kentucky	7,267	384	1	92
Missouri	25,496	2,521	191	93
Ohio	36,213	1,710	2,105	93
Oklahoma	8,316	563	212	99
Total	188,536	13,382	31,637	95

Of the stripped area 32 thousand acres have been planted and 13 thousand acres have reforested naturally. Ninety-five percent of the stripped area is potentially productive forest land. The remainder is toxic and therefore not plantable. In Indiana and Illinois the area of plantations is large. Study of these plantations will indicate tree growth possibilities on these lands.

During the year more than 115 thousand trees were planted on 37 different areas in the region to determine the forestation possibilities of various classes of strip-mined lands. These planting areas are well scattered over the entire region. Periodic examinations of these areas and others previously established will indicate the character of spoil banks on which forest plantings are most likely to succeed, and the rates of growth that can be expected by different species under varying site conditions and planting methods. The number of plots established to date is shown in Table 2. The number of species used per test varied from 1 to 17. The tests of species adaptation to site and of the effects of leveling on tree survival and growth usually covered 10-17 species. The others generally involved fewer species. Asterisks indicate tests that serve a dual purpose and have been counted elsewhere in the table.

Table 2.--Number of seeding and planting tests established on strip-mined lands in the Central States region by kind of test, state, and year of establishment

Kind of test	Ohio			Indiana		Ill.	Mo.	Kans.	Okla.
	1937	1946	1947	1945	1947	1947	1947	1947	1947
Species adaptation to site	1	3	2	2	2	5	5	4	1
Effects of leveling on tree survival and growth		4				1	1	1	
Suitability of various planting methods		2			2				
Suitability of mixed plantings of various species	*	*	2	*					
Suitability of direct seeding of various species			4		*	*	*	*	*
Suitability of underplanting		1			*	1			
Desirability of seeding of grasses and legumes with planted trees			4			2			

Preliminary analysis of data from these plots indicates that survival was less than 55 percent for jack, loblolly, ponderosa, pitch and Virginia pines in areas west of the Mississippi, where a severe drought occurred in July, August and September 1947. Survival of the native eastern redcedar

was best of all the conifers. With hardwoods best results were obtained with black locust, green ash, bur oak, and black cherry. Large, top-heavy 2-0 shortleaf pine was also included in these tests, but almost 100-percent mortality occurred within two months after planting. This severe loss is attributed more to poor stock than to species, since good stands of this species have been established on spoil banks in Missouri.

The various tests of the effects of leveling of spoil banks on tree growth need to be studied for another year, at least, before conclusive results are obtained. Trends indicate slower growth of trees planted on leveled banks composed chiefly of clay. In lighter-textured spoils survival and growth seem to be as good on leveled as on unleveled banks.

Direct seeding tests on spoil banks show some promise of success for heavy-seeded species such as bur, chestnut, and red oaks, and black walnut. Considerable losses were sustained in the coniferous seedings due mainly to sheet and gully erosion.

A classification system for strip-mined lands has been prepared for use as a tentative planting guide. This system is based on the acidity, texture, and proportion of soil in the spoils material, together with topography and stability of banks, character and density of existing natural vegetation, and character of material comprising the overburden. Planting experiments and plantation studies have indicated that these factors have a direct bearing on the suitability of spoil banks for forest planting.

Plans for 1948

Plans for 1948 include the publication of results obtained during the past three years in reconnaissance work, planting experiments, and special studies. A regional report is planned which will show: (1) the character and extent of strip-mining, (2) a classification of spoils and (3) planting recommendations insofar as available information will permit. More detailed reports of a similar nature will also be prepared for some of the states. A planted experiment to test species adaptation to spoil banks in Kentucky will be established in the spring of 1948. Simultaneously some planting will be undertaken in Ohio, Missouri, Kansas, and Oklahoma. Remeasurements of the older plantations will be taken in the fall of 1948, and special studies on moisture relationships will be conducted on experimental areas set up to test the effects of leveling.

FOREST SOILS

Progress and accomplishments in 1947

A soil survey of the Kaskaskia Experimental Forest, Hardin County, Illinois, was made during June 1947. Soil types were mapped, and the extent of their depletion through fire and erosion was recorded. Some

areas had been severely damaged by the removal of the erosive loessal mantle. Some were moderately damaged and others only slightly. After twelve years of protection from fire and grazing some degree of soil recovery was noted on certain areas. The result of this survey together with detailed descriptions of soil types will serve as a background and partial guide in evaluating bare lands for reforestation. Training in soil survey techniques was provided one of the district foresters of the Indiana Conservation Department who was assigned to the project as a cooperator.

The paper was prepared on the relationship of replaceable calcium in littler and soil to the distribution of forest types in the Central States region. The data came from a previous study of twenty-two virgin forest soils and adjacent field soils. This investigation shows that the quantity of calcium in litter and soil does not indicate the character of the forest cover to be expected. It also indicates clearly that the concentration of calcium in the organic horizon is a result of the moisture in the soil and is only indirectly related to the occurrence and growth of different kinds of forest.

Plans for 1948

Soils work planned for 1948 includes the preparation of an article for the 1948 Yearbook of Agriculture. This paper will show how forests through their litter develop and maintain soil porosity, thereby greatly increasing the percentage of rainfall absorbed. It will also tell how repeated burning reduces the porosity of the soil and makes reforestation more difficult.

During the coming year we plan to initiate a series of soil-site studies on unstripped land lying within the mined area. These studies will show the relationship of soil profile variations to the success of natural and planted stands. These studies should provide the forest manager with rough guides, at least, for predicting the probable success of forest plantings on given sites.

A study of sulfur toxicity of spoil banks is also planned for 1948. A small percentage of spoil bank material contains iron sulfides. This sulfurous material is toxic to practically all plants. As an aid in establishing forest plantings on spoil banks much more information is needed regarding the total quantity of sulfides in the spoil banks. Furthermore, we need to know how rapidly these sulfides are oxidized, and how rapidly the resultant toxic substances diffuse and disappear from the soil. We also need to know the speed and effectiveness with which they can be neutralized with lime.

Progress and accomplishments in 1947

The past year's work in silviculture has dealt largely with the analysis of data on completed studies, remeasurement of permanent sample plots, and the development of research center programs.

Studies on factors affecting the sprouting of blackjack oak have yielded further information that should help forest managers improve the composition of low-grade forest stands by reducing the proportion of this species. Data on these studies presented in the Annual Report for 1945 showed that shallow-girdled trees sprouted less profusely than did deep-girdled trees. A more detailed breakdown of these data reveals that the proportion of trees with living sprouts after five years is essentially the same for trees girdled to a depth of one-fourth, one-half and three-fourth inches into the sapwood (Figure 1). It is believed that increasing the depth of a girdle beyond three-fourths inch, even to the extent of severing the tree, will not result in more sprouting. However, decreasing the depth of girdle below one-fourth to at least one-twentieth inch results in a definite decrease in sprouting, the rate of decrease being greater at the shallower depths. Because of the difficulty of removing a complete

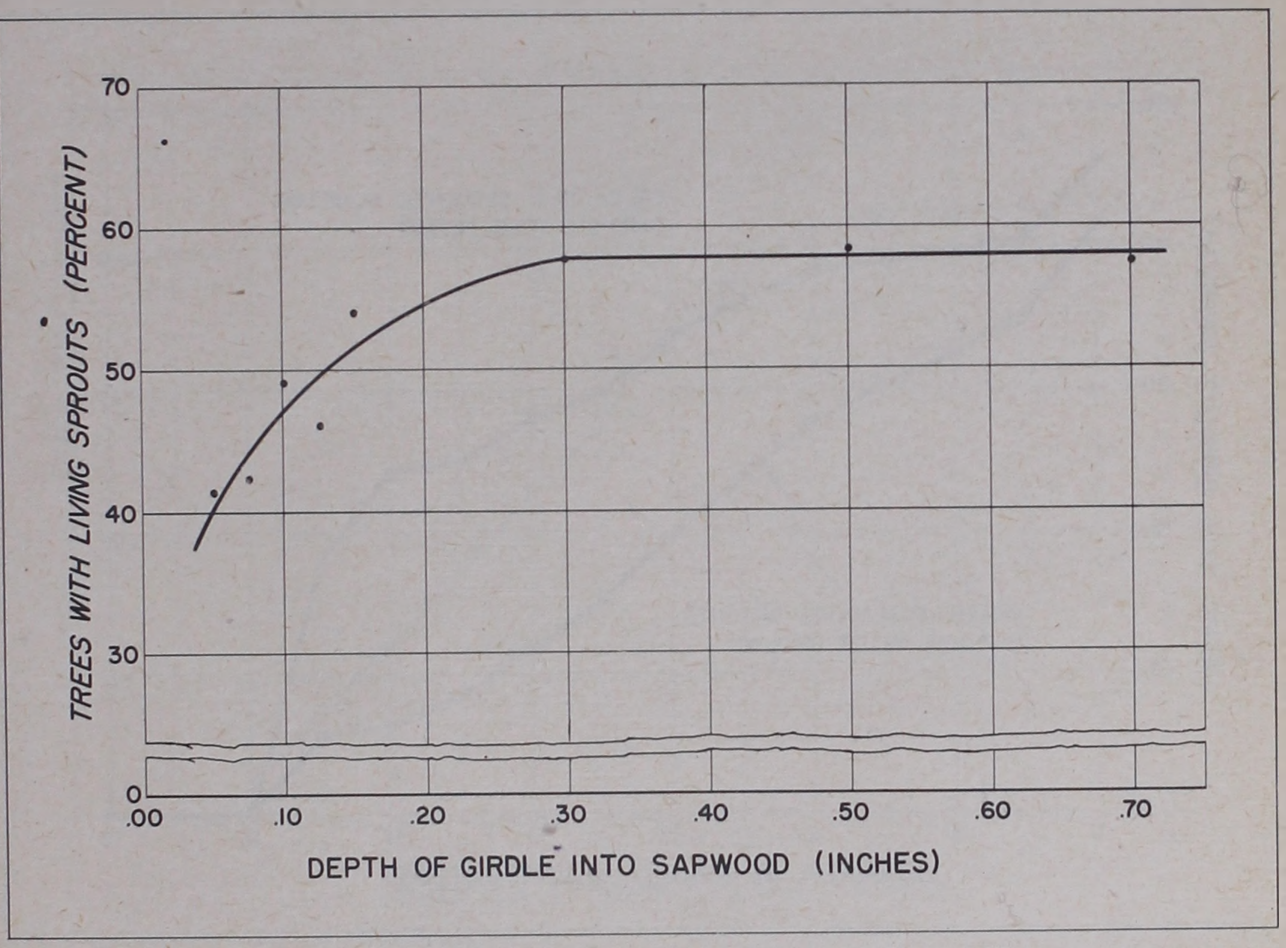


Figure 1.--Relationship of depth of girdle and the proportion of blackjack oak trees with living sprouts five years after girdling.

ring of bark without removing or injuring some sapwood, data on the effects of still shallower girdling on sprouting are not available. Theoretically at least, sprouting should decrease still more with further decrease in the depth of girdling. Therefore, if girdling is to be effective in reducing sprouting, the girdle must not extend more than one-fourth of an inch into the sapwood, and the shallower it is the less the sprouting will be. If, on the other hand, the girdle is to be at least one-fourth of an inch deep, the actual depth makes no material difference in subsequent sprouting.

The relationship of breast-high diameter of girdled trees and: (1) the proportion of trees that sprout, (2) the crown area of girdled trees at time of girdling, (3) the crown area of resultant sprout clumps five years after girdling, and (4) the time required for girdling, provides a basis for evaluating the benefits to be derived from girdling trees of different diameters.

The proportion of girdled trees that sprouted varies indirectly with the diameter of the tree as shown in Figure 2. The proportion of trees with living sprouts five years after girdling is almost a direct-line relationship and decreases from 83 percent for 1-inch trees to 0 percent for 13-inch and larger trees. The sprout mortality was greater for the larger

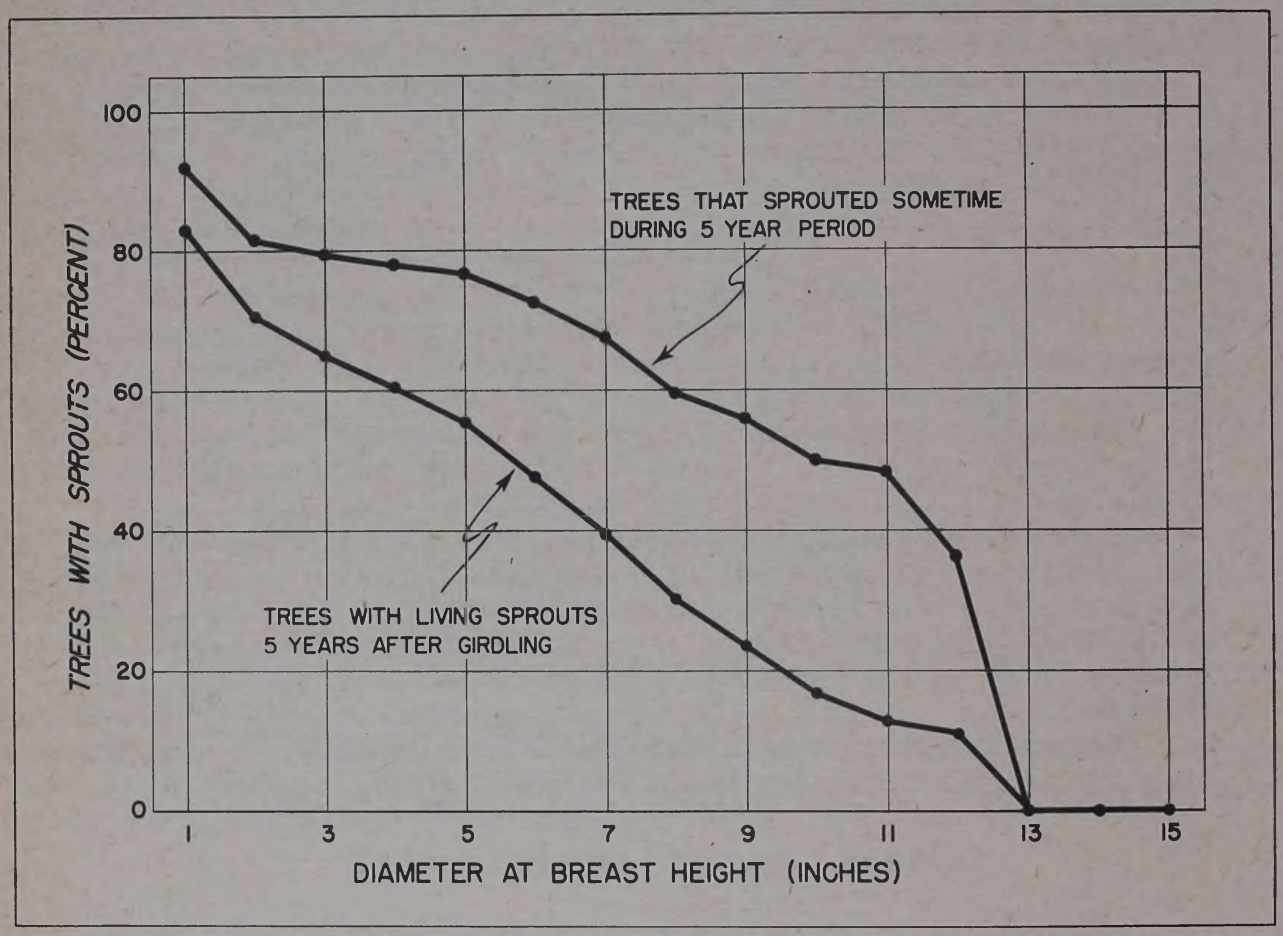


Figure 2.--Relationship of diameter of blackjack oak trees and the proportion of trees with living sprouts.

trees and is represented by the distance between the two curves.

The average crown area of the girdled trees increased progressively with increase in tree diameter from about 6 square feet for 1-inch trees to about 500 square feet for 14- and 15-inch trees. The diameter of the parent tree did not materially affect the crown area of the resulting sprout clump five years after girdling. The time required for girdling a tree increased with increase in diameter and ranged from about 2 minutes for 1- to 4-inch trees to about 7 minutes for 13- to 15-inch trees.

The curve shown in Figure 3 combines all these relationships and shows the much greater benefits to be derived from girdling the larger trees. The curve was developed by: (1) determining the number of 1-, 2- . . . and 15-inch trees which could be girdled by one man in an 8-hour day, (2) calculating the differences in the total crown area of these different sized trees at the time of girdling and the area occupied by the 5-year old sprout clumps that developed on these trees, and (3) plotting these differences, or reductions in crown area, over tree diameter.

Insofar as crown area is concerned, time spent in girdling the 1-inch tree is wasted. At the end of five years the sprout clumps on the 1-inch

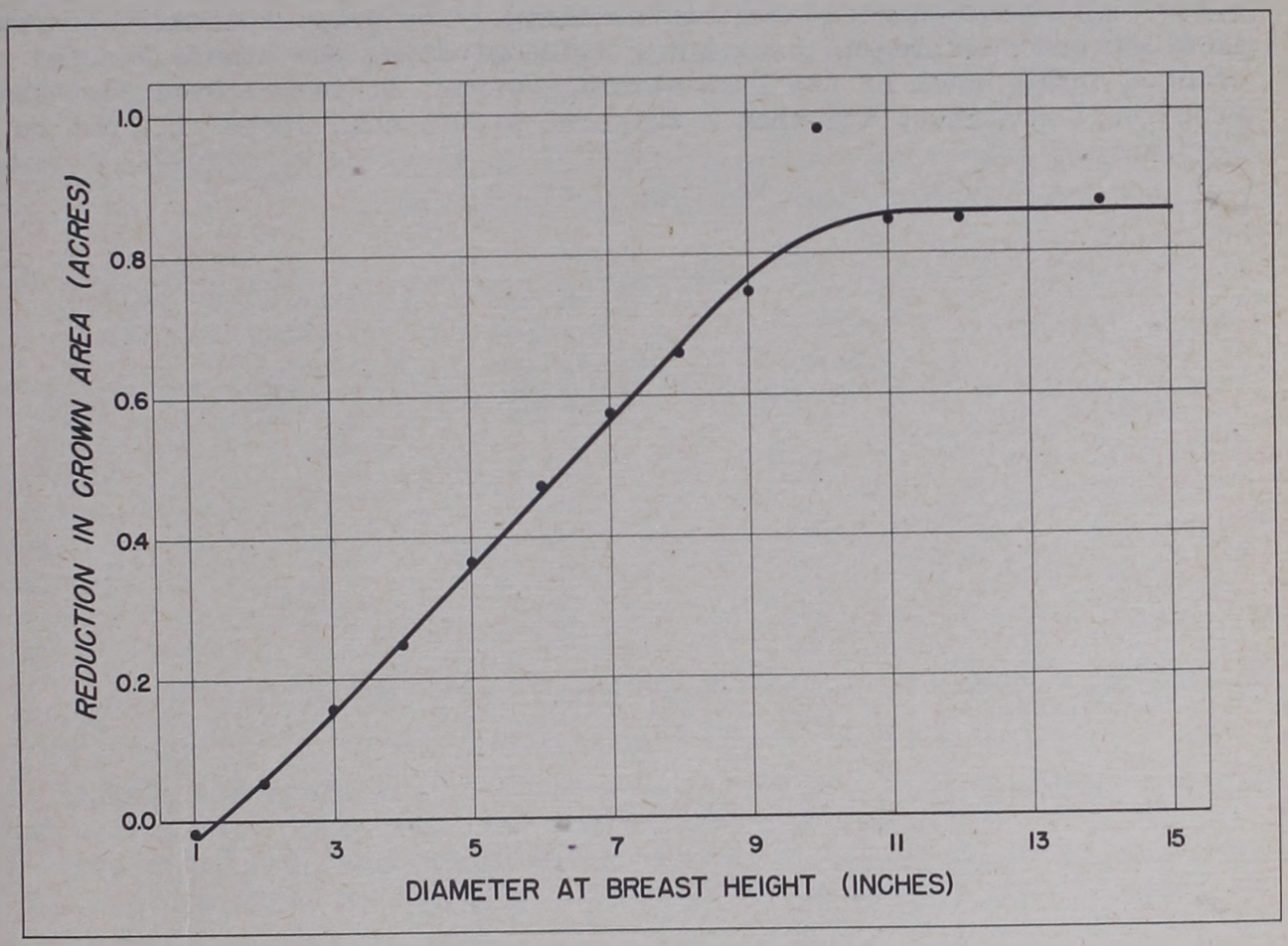


Figure 3.--Reduction in crown area--crown area of girdled trees less that of sprout clumps on the same trees five years later--accomplished by one 8-hour day's girdling for each d.b.h.class.

trees that could be girdled in an 8-hour day occupy more space than the crowns of the original trees. A small reduction in crown space results from girdling 2-inch trees. The reduction increases directly with an increase in diameter to about 10 inches, at which point reduction of crown area increases only slightly with further increases in diameter In other words, if one man spends eight hours girdling 10-inch and larger blackjack oak trees, he can reduce the area occupied by these trees or their sprouts by about 0.8 to 0.9 of an acre. Two men girdling 5- and 6-inch trees, and six men girdling 3-inch trees, would be required for an equal crown reduction. In the stands in which the work was done 94.4 percent of the total crown reduction was accomplished by girdling trees 4 inches and larger. Girdling 1- and 2-inch trees accounted for only 0.6 percent of the total reduction. Obviously, girdling these small trees is of questionable value, and girdling the larger trees should have highest priority when the objective is to increase growing space for higher-value trees.

Survival counts and height-growth remeasurements were made on the shortleaf pine direct seeding plots. These were established to test the feasibility of seed spot reproduction for increasing the stocking of shortleaf pine in stands of blackjack oak and other low-quality species. Both survival and growth continue to be good. At the end of the sixth growing season some of the trees are 15 feet high. Many of the seed spots still contain more than one seedling. The proportion of the spots in which one seedling is outgrowing and dominating the others has increased during each of the last several years. It is believed that this trend will continue, and that a thinning within seed spots will not be necessary.

FOREST UTILIZATION SERVICE

The objective of the Forest Utilization Service is to improve wood utilization through the application of most efficient equipment and procedures in the harvesting, treating, manufacturing, and fabricating of forest products. Wartime shortages of lumber and other products made of wood have focused attention on the need for making what we have go farther. One means to this end is to put research findings in the field of forest products utilization into wider practice. New research must be undertaken on utilization problems still unsolved. The two Station FUS men are essentially field representatives of the Forest Products Laboratory at Madison, Wisconsin. They visit primary and secondary wood utilization establishments for the purpose of learning the technical problems that the Laboratory might be in a position to solve. Simultaneously they carry to these establishments the findings of the Laboratory.

Progress and accomplishments in 1947

The FUS unit was fully staffed during only a short period of the year. Consequently the number of visits to industrial operators and others interested in better wood utilization was curtailed. However, in connection with the consulting and advisory phases of the project, the two FUS men personally visited 330 wood-using or-producing industries, trade or industrial associations, equipment manufacturers and other establishments and individuals as shown in Table 3.

Table 3.--Number of contacts of FUS men with industry operators in the Central States region by states, 1947

State	Primary 1/ industry operators	Secondary 2/ industry operators	Other 3/ operators	Total
	Number	Number	Number	Number
Illinois	6	33	17	56
Indiana	32	47	10	89
Iowa	2	10	3	15
Kentucky	23	17	5	45
Missouri	22	29	9	60
Ohio	19	34	12	65
Total	104	170	56	330

1/ Loggers and producers of lumber, ties, staves, veneer, posts, pulpwood, wood chips, etc. Also includes wood-treating plants.
2/ Processors and fabricators using primary forest products to make furniture, containers, millwork, plywood, laminated wood, turned products, paper, etc.
3/ Industry Association, public and private research agencies, equipment manufacturers, state forestry departments, forestry schools, etc.

Table 4.--Number of written inquiries from the Central States region regarding forest products and their utilization, by subject-matter designation and state, F.Y. 1947 1/

Forest Products Laboratory Division	Subject-matter class	State						
		Total	Ill.	Ohio	Ind.	Mo.	Ky.	Iowa
		No.	No.	No. 2/	No.	No.	No.	No.
	Total	1770	668	403	279	206	111	103
TIMBER PHYSICS	Seasoning and moisture control	338	102	63	73	50	34	16
	Moisture meters, plasticising, wood bending, shrinkage, high-frequency	69	30	13	11	7	6	2
	All other phases of TP research	60	33	8	6	7	0	6
WOOD PRESERVATION	Adhesives, veneer and glued-up products	209	84	44	40	12	15	14
	Preservative treatment, water repellents	143	50	34	17	26	6	10
	Painting, finishing, bleaching	86 3/	36	21	13	7	4	5
	All other phases of WP research	43	17	11	1	12	0	2
INDUSTRIAL INVESTIGATIONS	Remanufacture and uses of wood	124	52	28	25	8	3	8
	Harvesting and primary manufacture	61	16	9	13	9	5	9
	Utilization of waste	58	18	19	7	7	4	3
	All other phases of II research	82	26	21	8	18	2	7
DERIVED PRODUCTS	Derived products	75	25	29	7	9	4	1
	Modified woods	41	19	7	9	2	3	1
	All other phases of DP research	29	9	14	3	1	1	1
TIMBER MECHANICS	Construction, prefab., joints and fastenings	80	38	13	9	4	7	9
	All other phases of TM research	58	23	15	11	4	2	3
CONTAINERS	All phases	90	53	15	7	7	7	1
PULP & PAPER	All phases	60	18	25	6	10	0	1
SILV. RELATIONS	All phases	54	15	12	11	5	7	4
	Inquiries not classifiable above	10	4	2	2	1	1	0

1/ Based on replies written by the Forest Products Laboratory (99 percent), and the Washington Office Division of Forest Products (1 percent).

2/ Excludes 26 letters to Wright Field, Dayton--not representative of general regional interest.

3/ Principally fire retardents and fire tests.

In the field of secondary industries, special emphasis will be given to: (1) the analysis of their technological problems, (2) providing the Laboratory with material for testing the suitability of hardwood waste from this region for paper and roofing products, (3) working with industry on this same problem, (4) providing advisory service to the Cooperative Wood Waste Development Association, particularly with respect to production of hardboard and molasses, (5) cooperating with the Laboratory on studies of the control of wood-moisture content for the furniture industry, and on seasoning problems of the tight cooperage industry, (6) working with industry and the Laboratory in developing modified woods for specialized uses where natural wood is a source of warping and other troubles, (7) observing, with a gluing specialist from the Laboratory, present gluing practices in the region and sponsoring, if necessary, gluing demonstrations by the Laboratory for bringing industry up-to-date on the results of gluing research.

Both FUS men will work closely with the Station research centers in stimulating needed research and demonstrations in such fields as timber harvesting, preservation of fence posts and farm timbers, testing of new equipment such as chain saws, light logging carts, and arches. They will also advise research center leaders in establishing projects designed to secure the most complete utilization of logging tops and limbs, low quality trees, and culls.

FOREST ECONOMICS

FOREST SURVEY

The Forest Survey at this Station is a part of the Nation-wide survey of forest lands being conducted by the Forest Service. Its purpose is to determine the forest area, timber volume, growth and cut, probable future requirements for wood, and to interpret these findings as an aid in formulating policies for forest land use.

Progress and accomplishments in 1947

Forest Survey work during the year was concentrated in Missouri and Illinois. Progress will be shown for each state separately in five phases: (1) inventory, (2) drain, (3) computation, (4) growth, (5) reports.

The first step in the inventory phase of the Forest Survey is the examination of aerial photographs to determine the forest area. In Missouri 196,000 systematically spaced points on aerial photographs were examined. The percentage of the points that fell on forest areas in each county was applied to the total land area of the county to obtain the forest area. Approximately 26,000 of the points falling on forest land were selected for further examination under stereoscope. By measuring on the photographs tree height, width of crown, and density of stand, the area surrounding the point was classified by stand-size class; i.e., as saw timber, pole timber, seedling and sapling, or poorly stocked stands. More than 2,600 of these plots were subsequently located on the ground. At each location a one-fifth-acre circular plot was established. On each plot field men checked the photo interpreters' stand-size class determination, and on a tally sheet recorded the number of trees by species and diameter class, rate of diameter growth, and other descriptive data. Inventory work in Missouri was begun in July 1946 and completed in September 1947.

Timber-drain studies were made in 1947 to determine the volume cut from the forests of Missouri during 1946. All primary wood-using industries in the state, with the exception of sawmills, were visited and reports were obtained covering the quantity, species, and size of trees cut. Production data for the lumber industry for 1946 had already been obtained through a cooperative project of the Forest Service and the Civilian Production Administration.

The volume of wood cut for fuel and fence posts was determined by drawing at random from the Master Sample of Agriculture for Missouri a total of 114 segments. Each contained approximately 6 farms and included a definite area that could be located on the ground. In each segment field men visited all farmers and other forest land owners or timber operators and questioned them regarding their production of fuelwood and fence posts during 1946. The total volume of fuelwood and fence posts produced by the farmers and land owners in these segments was expanded by appropriate converting factors to give an estimate of the volume of fuelwood and fence posts produced in the entire state.

A part of the volume of standing trees does not get into the final product, but is lost through breakage, woods waste, and mill waste. Special studies were therefore necessary to determine the volume of woods waste resulting from breakage in logging operations and from failure to utilize all sound material in cut trees. Similarly, mill studies were made to compare the volume of lumber and other products cut with the scaled volume of the log.

All drain studies for Missouri were completed during the year and tabulations were prepared showing the volume of timber cut for all forest products.

The first step in the computation of inventory data was the transfer of essential information from the field tally sheets to International Business Machine punch cards. This work was done in the Columbus office. The timber volume information was then compiled on tabulating machines. By the end of 1947, forest area data were computed for all counties in Missouri and board-foot and cubic-foot volumes of standing timber were compiled for the Ozark portion of the state.

Forest growth information for Missouri was obtained from increment borings taken on sample trees occurring on the field survey plots. The office compilation of growth data was begun in the latter part of the year, and was approximately one-third completed at the end of the year.

Five brief statistical reports are planned for the major forest regions into which Missouri has been divided. These reports will contain forest area and timber volume information but not growth nor drain. By the end of 1947, data for the first of these regional reports were compiled and assembled.

In addition to the statistical reports, a comprehensive analytical state report will be prepared to give a complete picture of the forest resource situation in the state. A beginning was made on the preparation of this report. An outline was prepared and discussed with agencies and individuals in the state. Historical and economic background information was gathered, and the introductory chapter prepared in rough draft from.

For the state, some of the significant survey findings are: The forest area is 15,187,000 acres or 34.3 percent of the total land area. Since detailed forest area and timber-volume calculations have been completed for only the three Ozark regions (see Figure 4), the data in the following tabulation cover these regions only.

	Thousand acres
Total land area	16,765
Total forest area	10,222
Total commercial forest area	10,122
Saw-timber area	1,061
Pole-timber area	4,436
Seedling-sapling area	3,589
Poorly-stocked area	1,037

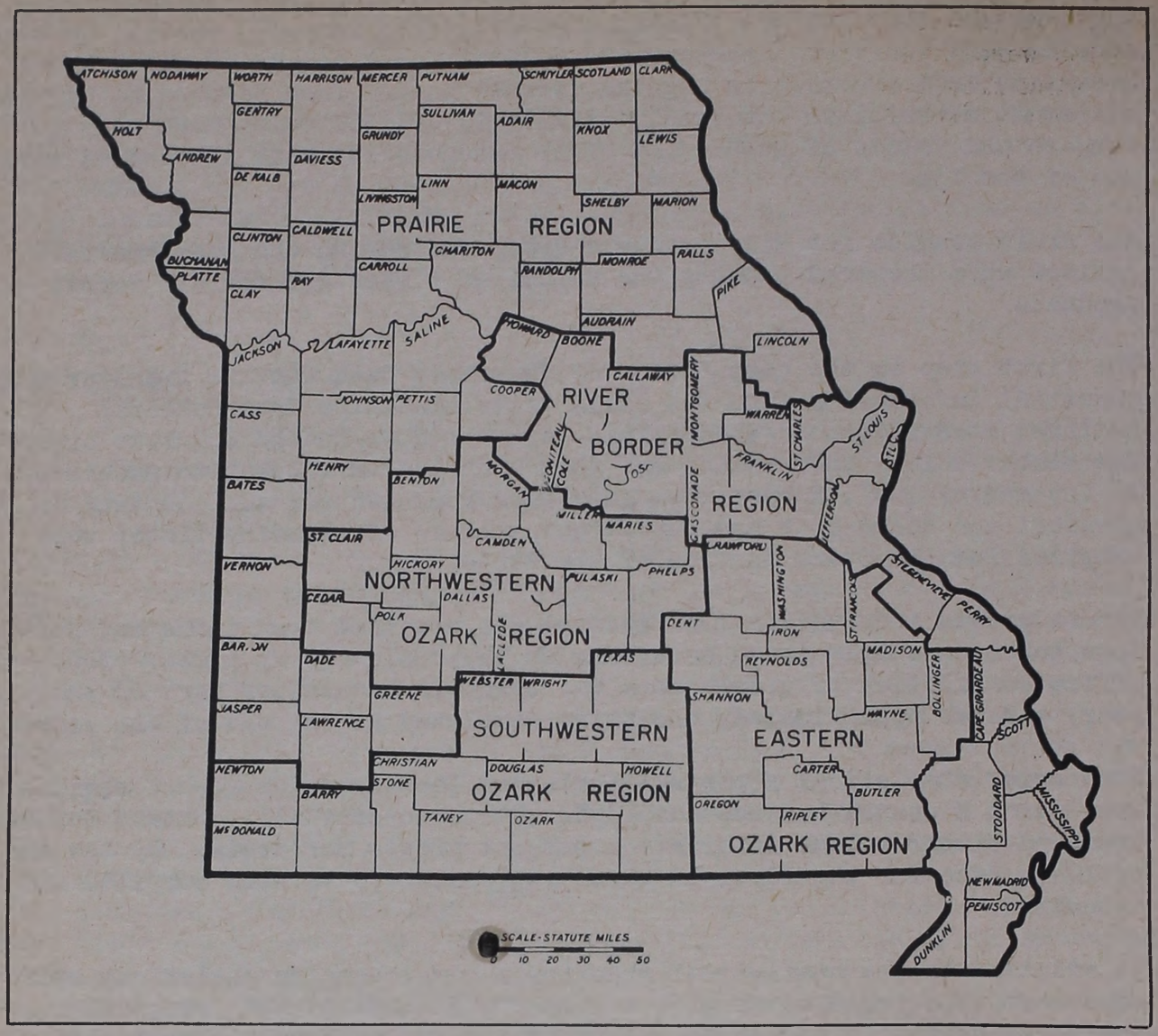


Figure 4.--Forest survey regions in Missouri.

The tabulation shows that 61 percent of the total land area of the Ozark portion of the state supports forest. Approximately 10 percent of the commercial forest area supports saw-timber stands, 45 percent pole-timber stands, and 35 percent seedling and sapling stands. The remaining 10 percent is not sufficiently well stocked to be included in any of the preceding classes.

The total volume of saw-timber in the three Ozark regions is 6.4 billion board feet (International 1/4-inch log rule). The average volume per acre is only 630 board feet.

Lumber production in the entire state of Missouri for 1946 was estimated to be 528 million board feet. Lumber and fuelwood were the two principal forest products cut, accounting for over 75 percent of the total drain. The total volume of drain and the relative importance of the principal forest products are shown in the following tabulation.

Product	Thousand cu. ft.	Percent
Lumber	82,115	57
Fuelwood	29,779	20
Tight cooperage	13,452	9
Fence posts	8,153	6
All others	11,397	8
Total	144,896	100

In Illinois, the Forest Survey work is being done in cooperation with the Department of Forestry, University of Illinois, and the Division of Forestry, Illinois Department of Conservation. The state agencies are providing technical personnel to aid in intensifying the Forest Survey inventory work particularly in the southern 16 counties of the state. One full-time state employee has worked as a member of the Survey field crews since the Illinois inventory work was begun.

Photo interpretation work was begun in Illinois in August 1947 and field work in October. By the end of the year, interpretation of aerial photographs was completed on approximately two-thirds of the state and field examination had been made on 250 forest plots covering the northern half.

Plans for 1948

The office computations of Missouri inventory data will be completed early in the year and statistical reports will be published presenting the forest area and timber volume data for each of the five regions into which the state has been divided. Forest growth computations will also be made. An analysis will be made of growth and drain in order to determine if the forest growing stock is currently being built up or reduced. The first draft of a comprehensive report on the forest resources and industries of the state will be prepared, revised, and made ready for publication.

In Illinois, the photo interpretation phase of the survey will be completed by early March and the inventory field work by May. Computation of the forest area and timber volume data will begin as soon as field work is completed and is scheduled for completion before the end of the year. Two statistical reports for subdivisions of the state will be prepared as soon as inventory tabulations are completed.

The drain phase of the Forest Survey in Illinois will be conducted as a cooperative project by the U. S. Bureau of the Census; Illinois Agricultural Experiment Station; the Division of Forestry, Illinois Conservation Department; and the Central States Forest Experiment Station. The Bureau of the Census will obtain production data for all sawmills, cooperage plants, and veneer mills using Illinois timber. The state agencies in cooperation with the Central States Station will obtain information on the production of fuelwood, fence posts, mine timbers, pulpwood, handle stock, and miscellaneous items. The data from the several cooperating agencies will be assembled and compiled by Forest Survey

personnel. Present plans call for the completion of the field canvass by the Bureau of the Census and by other cooperating agencies by August. Drain computations should be completed by the end of the year.

Photo interpretation and inventory field work will begin in Kentucky as soon as these two phases are completed in Illinois. Present plans call for an intensity of survey in Kentucky comparable to that used in Missouri. On this basis the inventory phase of the work in Kentucky will require three photo interpreters and six field men for a full 12-month period. The conservation agencies and many of the wood-using industries in Kentucky desire a more intensive forest survey in order that accurate inventory data will be available by counties or small groups of counties. They have asked the state legislature to supplement Forest Survey funds for Kentucky. If state funds are made available, a cooperative program will be developed with the state to provide for a greater intensity of sampling and the release of data by smaller subdivisions.

FOREST PRODUCTS REQUIREMENTS, PRODUCTION, AND SUPPLIES

Progress and accomplishments in 1947

In cooperation with the Civilian Production Administration and the Office of Housing Expeditor the Station continued to provide data on lumber production and stocks on hand in the Central States region. During the period January through May monthly estimates were prepared and submitted to Washington for incorporation into national estimates. This activity was discontinued at the end of May because of lack of urgent need for this information on the part of these public agencies.

The estimates for this region showed the total monthly production of lumber by states, mill sizes, and principal species groups. Similar reports were prepared showing stocks of lumber at the mills and in concentration yards. These estimates were based on monthly reports from about one thousand representative sawmills in Ohio, Indiana, Illinois, Iowa, Kansas, Nebraska, Missouri, and Kentucky. These sample mills were selected to represent all types of mills in the region. Some were farm mills operated only a few days each year. Others were well equipped mills producing high-grade lumber.

In addition to lumber production and stock estimates, a monthly report on factors affecting lumber production was prepared for the North- and South-Central Hardwood regions for the months January through April. This report was based on observations of field men supplemented by information obtained from mill operators regarding the effect on lumber production of such factors as weather, manpower, equipment and supplies, costs, prices, raw materials, markets, government regulations, and management policies.

Progress and accomplishments in 1947

Early in February, a technical man was assigned to work on regional economic studies. His first task was to condense the Worthington and Kirkland manuscript, "The Function of Woodlands in Corn Belt Farming," which was completed in 1943. The condensation was issued as Station Technical Paper No. 107 entitled, "Farm Woodlands in the Corn Belt Region of Illinois." It drew from the original manuscript the major facts and conclusions applicable to Illinois.

The second line of work was to study the economics of producing pulping chips from unpeeled wood. In the Central States region asphalt roofing plants provide a market for such chips. There are indications that manufacturers of such other items as container and building board may turn to unpeeled hardwood as a raw material. If harvesting and transporting costs can be sufficiently reduced, and if certain refinements in processing can be worked out, more logging and primary manufacturing waste and cull and low-quality trees may be put to profitable use.

The problem of wood-waste utilization is Nation-wide, and research results in one region may be of value in several other regions. To stimulate discussion and avoid duplication of effort, copies of our working plan were distributed to all Regional Foresters and Directors. Cooperative arrangements were made with the Forest Products Laboratory through which the latter undertook some technical phases of the study, such as determining the minimum qualities of chips suitable for different products.

Field studies of the costs of harvesting, transporting, and chipping wood were begun in the summer. They centered in Ohio and Illinois where most of the wood used for felt and roofing is secured. Contacts were made with timber owners, loggers, and men in the roofing industry, and a number of woods and plant operations were studied. Average cost figures, in terms of man-hours and dollars, were obtained through interview and observation. "Case Histories" were prepared covering the methods and costs of typical operations involving different kinds of equipment in various kinds of timber stands. These were sent to the Forest Products Laboratory where they were mimeographed and distributed to all Regional Foresters and Directors.

Thus far, the study has focused attention on some significant trends in the utilization of wood by the felt and roofing industry. Shortly before the war, when wood fibers were first substituted for rag fibers by this industry, little was known of the suitability of various species and qualities of wood for this use. At first nearly all species and qualities were accepted. With use, operators learned, or thought they did, that certain species or qualities of wood were less satisfactory than others. Hard hardwoods, such as oak and hickory, frequently caused breakdowns in their fiberizing machinery. Breakdowns added to production costs and retarded production schedules. During 1947 many local wood buyers began limiting their purchases to such soft hardwoods as cottonwood, soft maple, and willow. This practice temporarily limits the

opportunity to utilize woods waste and low-quality trees of the hard heavy species.

At present, wood buyers have little difficulty securing their quota of the soft hardwoods. The current high prices for agricultural crops stimulate land clearing in the bottomlands where the soft hardwoods are common. With a pronounced decline in the prices of agricultural crops, the availability of these choice species may be changed. Furthermore, research may overcome objection to the harder woods. Eventually the local supply of these softer woods may be so reduced through cutting that harder woods will be used.

Many farmers and some foresters believe that cutting young pole stands of cottonwood, soft maple, and other bottomland species on a pulpwood rotation is the most profitable system of managing these species. In consideration of the relatively large aggregate area of such stands along the Mississippi River and its tributaries and the very rapid growth rate of the principal species, it would appear that the phase of the present study dealing with the comparative income per acre per year growing bottomland hardwood species to a pulpwood or to a sawlog rotation should be emphasized in future work.

Plans for 1948

The collection of cost data by this Station will be completed in the spring or early summer of 1948. Sufficient data have already been gathered on the types of cutting which currently account for most of the feltwood used. Because private operations are nearly 100 percent clear-cutting, it will be necessary to obtain data on partial cuttings from state, national, or other public forest land. This year's studies will be confined to woods operations on such lands and such other private operations as are needed to fill in gaps in the data.

First publication of results will probably be in the form of a Station Technical Paper. This will cover the main points of wood-use by the felt industry, explaining trends, outlining costs, describing obstacles to better utilization, and suggesting some improvements. The paper should be issued in the fall. A short article for a trade journal may be prepared, dealing with the problems of wood procurement and handling. Finally, it may be desirable to combine our cost information with the Forest Products Laboratory technical data on equipment and processing methods to present a complete picture of the use of unbarked hardwoods for pulp chips. This possibility partly depends upon the plans of the Laboratory.

BRANCH STATIONS

AMES RESEARCH CENTER

The Ames Research Center was established at Ames, Iowa in July 1946. The research province served by this center includes, in addition to Iowa, adjacent areas of comparable forest land in southeastern Minnesota, southwestern Wisconsin, northwestern Illinois, and northern Missouri. At the outset, at least, it was decided to concentrate work within the State of Iowa, but to choose locations that would be representative of forest conditions throughout the province.

Progress and accomplishments in 1947

With one or two exceptions no large timber holdings are operated as forest properties in the province. This lack of sizeable timber tracts complicated the selection of experimental areas, which was one of the major jobs undertaken in 1947. Negotiations with the Iowa Conservation Commission for use of certain state forest lands for experimental purposes were started in 1946 and completed early in 1947. The Commission allocated for this use 1,870 acres of forest land in the Yellow River State Forest in northeastern Iowa. This area has been named the Paint Creek Experimental Forest. The Commission similarly allocated 500 acres of the Lee-Van Buren State Forest in southeastern Iowa and an equal area of the Lucas-Monroe State Forest in south-central Iowa. The exact location of the experimental tracts on these last two areas will be determined at a later date.

Negotiations with the Iowa Conservation Commission have resulted in the signing of a memorandum of understanding by the Commission and the Director of the Central States Forest Experiment Station. This memorandum outlines the responsibilties of each organization in the cooperative effort on these experimental tracts. Briefly, it provides that the Ames Research Center will plan and conduct a broad program of economic, silvicultural, ecological, and forest management research on the tracts and that the Commission will provide labor, equipment, materials, and supplies for the logging, thinning, and milling operations. The products will be the property of the Commission and will be sold in the most advantageous manner. Income from the sale of products is to be used to finance operations on the area.

Much of the planning essential to the establishment and development of a program for a new research center was completed during the year. In late July the Director and staff officers of the Central States Forest Experiment Station and R. D. Lane, of the Carbondale Research Center, met with the Ames personnel to consider a problem analysis for the research center province and to develop a program for solving the most important problems. Mr. F. H. Eyre, of the Lake States Forest Experiment Station, attended a portion of the meeting.

Initial research work will be undertaken on the Paint Creek Experimental Forest, a tract characteristic of a considerable area of "breaks"

bordering the Mississippi River in northeastern Iowa, northwestern Illinois, and adjacent portions of Minnesota and Wisconsin. The Experimental Forest is mostly wooded. The 350 acres in pasture will provide planting sites. The remaining 1,520 acres bear a forest composed of northern red oak, other oaks, hard maple, basswood, elms, butternut, aspen, and miscellaneous other species.

A survey of the Paint Creek Experimental Forest has provided much useful information about it. Field men have relocated the routes of abandoned roads traveled in the horse and buggy days, and a number of logging roads of years past. The relative site qualities of various portions of the tract and the character of the stands have been noted. The forest varies in composition depending on soil depth and exposure. On the uplands, particularly with a northerly aspect, northern red oak with varying amounts of sugar maple, elms, and basswood make up the stand. In most northern coves the forest is composed of sugar maple, basswood, butternut, slippery and white elms, and some hickory. On south slopes, short-boled oak--chiefly white, bur and northern red--occurs. Where soils are very thin and dry eastern redcedar is often present.

A headquarters site has been chosen near the center of the tract on an all-weather gravel road. A topographic survey of this site has been made by Conservation Commission personnel for use in developing and landscaping it. A three-stall garage has been built for trucks, tractors, and other heavy equipment. Several other small temporary buildings have been built. The abandoned farm structures on the site were razed, and usable material salvaged. The Commission plans to set up its sawmill at the headquarters. Grading for the log yard, roll-way, and sawmill site was completed before winter set in. Preliminary arrangements have been made with the Rural Electrification Administration to extend a power line into the headquarters area. An aerial photograph mosaic of the experimental forest was prepared by the photo interpreters of the Forest Survey in the Columbus office. A soils map was secured from the Soils Survey office of the Bureau of Plant Industry, Soils and Agricultural Engineering at Iowa State College.

The present road system on the experimental forest is wholly inadequate. A system of primary, secondary, and logging roads must be developed to permit access to all parts of the area for management, operation, and fire control purposes. A tentative plan for access and fire control roads has been prepared and two logging roads opened up. The Allamakee County Road Commissioners have cooperated on the road program by grading and widening about a half mile of abandoned access road.

Equipment for roadbuilding, logging, and other forestry work has been assembled by the Ames Branch and the Conservation Commission. The Ames Branch has secured a $2\frac{1}{2}$-ton truck, a TD9 crawler tractor with bulldozer blade and winch, three chain saws, a logging yarder or log cart, a tree planting machine, and many small tools. This equipment will be rented to the Conservation Commission in accordance with terms of a memorandum of understanding. The Commission is providing a 2-ton truck, a road grader, a T-40 crawler tractor, power saw, sawmill with power unit, edger with power unit, post peeler, and miscellaneous small tools and supplies. Purchase of additional and replacement equipment has been authorized by the

Commission as funds become available from the sale of products harvested on the forest.

Much of the effort and time expended on the experimental forest by the Ames Branch personnel went into selecting, inventorying, and developing preliminary management plans for, a farm forestry demonstration area of 78 acres. This tract will demonstrate good woodland management practices to farmers and timber-land owners. It will be managed as a forester thinks Farmer Jones should handle the woodlands on his north forty if he wishes to obtain the greatest returns from his timber. It contains about seven-tenths acre of open land and slightly over 77 acres of timber. A portion of the open land lying in a narrow strip along the west boundary of the tract will be planted to shrubs for wildlife cover and food, and the remainder will be planted to timber-producing species. About seven acres of the timber-land has been set aside as a natural area to be left unmanaged for comparison with the remaining 70 acres which are to be managed in accordance with the best known forestry practices.

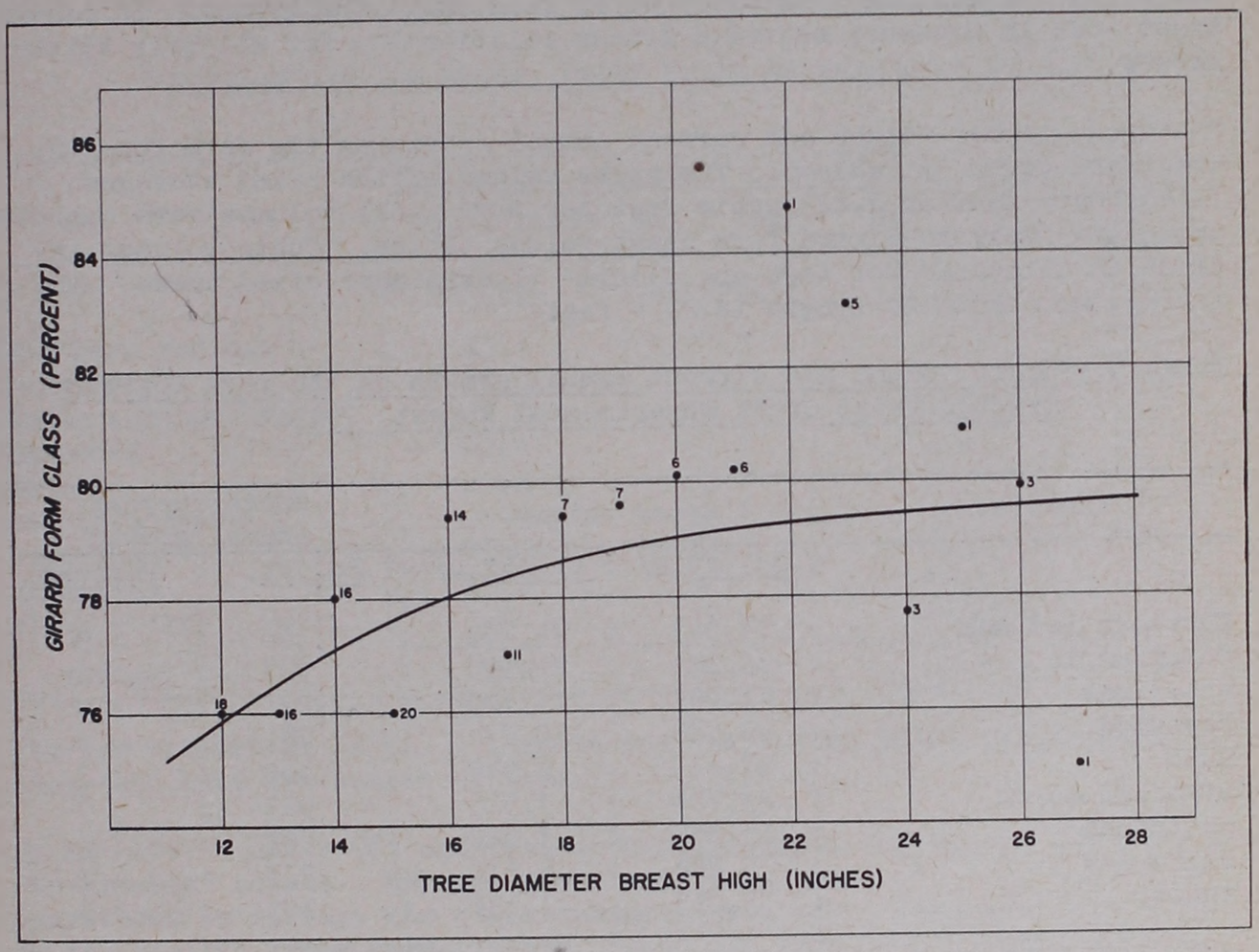


Figure 5.--The relation of Girard form class to tree diameter for northern red oak on the Paint Creek Experimental Forest, Allamakee County, Iowa.

As a part of a 100-percent inventory of the 70 acres planned for management, field crews determined the Mesavage-Girard form class of all trees of sawlog size. Tree form class varied somewhat by species, and in the case of red oak by diameter class (Figure 4). Because of the relatively small number of sample trees of species other than red oak an average form class of .77 was derived. The average form class of all red oak was .78.

Volume determination of the 135 measured red oaks using the average form class .78 gives a 2.1 percent lower volume than if the curved form class for each diameter were used. The latter procedure is, of course, the more accurate.

Compilation of bark-thickness data showed that for northern red oak and bigtooth aspen in northeastern Iowa the relation of double-bark thickness at 17 feet above ground to that at breast height is linear only until double-bark thickness at breast height reaches 1.5 inches. Thereafter additional increases in bark thickness at breast height are not accompanied by proportional increases at 17 feet above the ground. In contrast, oak in Missouri showed a linear relationship for all bark thicknesses.

The gross timber volume and current annual growth on the farm forestry tract are given in Table 5. The gross volume of the stand averages 7,146 board feet or 2,223 cubic feet per acre. All volumes were computed using the Mesavage-Girard form class volume tables. Cubic volumes include an allowance for tops and limbs of sawtimber-sized trees. The average merchantable length is 29.4 feet.

Table 5.--Gross volume and current annual growth on the farm forestry tract[1/] Paint Creek Experimental Forest, 1947

Species	Gross volume		Gross current annual growth	
	Bd. Ft.[2/]	Cu. Ft.[3/]	Bd. Ft.	Percent
Northern red oak	279,943	74,703	5,368	1.9
Sugar maple	60,174	21,955	907	1.5
White oak	41,067	17,440	1,231	3.0
Basswood	39,586	10,834	787	2.0
Elms	27,473	9,540	560	2.0
Bigtooth aspen	23,784	7,518	923	3.9
Butternut	15,554	5,620	547	3.5
Hickories	5,848	4,510	275	4.7
Ashes	3,813	1,334	105	2.8
Other species[4/]	5,605	3,001	184	3.3
	502,846	156,455	10,887	2.2

1/ Comprising 70.37 acres.
2/ In trees 11.6 inches d.b.h. and larger.
3/ In all trees 4.6 inches d.b.h. and larger, including tops and limbs of sawtimber-sized trees.
4/ Includes black walnut, bur oak, black cherry, eastern cottonwood, paper birch, boxelder, and hackberry.

In taking increment cores for growth calculations, the field men observed that growth had slowed down markedly during the last 10 to 12 years. Apparently the area is overstocked, and sufficient mature timber should be removed to increase the growth rate. The desirable average volume appears to be about 4,000 to 4,500 board feet per acre which means a reduction of 2,500 to 3,000 board feet per acre. Gross current annual growth was 155 board feet per acre. Of this about 88 board feet was on trees of sawtimber size and 67 board feet was ingrowth. The growth percent was 2.2 percent. The gross current cubic growth per acre was 36.2 cubic feet on all trees 4.6 inches and larger in diameter, and the growth percent of this material, which includes tops and limbs, was 1.6 percent.

As a part of the inventory of the farm forestry tract, logs in trees of sawtimber size were graded, and the results shown in Table 6. This grading was based on a variable log length in order to realize the maximum quality yield. The log-grading rules for northern hardwoods designed by the Forest Products Laboratory in 1941 were used.

Table 6.--Proportion of the gross volume on the farm forestry tract by species and log grade, Paint Creek Experimental Forest, 1947

Species	Proportion of gross volume by log grade: No. 1 logs	No. 2 logs	No. 3 logs	Basis: trees graded
	Percent	Percent	Percent	Number
Northern red oak	33.3	25.3	41.4	167
Sugar maple	40.0	14.3	45.7	28
White and bur oak	9.8	20.7	69.5	29
Basswood	42.6	27.7	29.7	25
Elms	26.6	39.2	34.2	35
Bigtooth aspen	--	37.7	62.3	22
Butternut	15.2	28.2	56.6	16
Hickories	15.8	22.7	61.5	9
Black cherry	--	73.2	26.8	3
Average	29.5	26.2	44.3	334

The low proportion of No. 1 logs is due chiefly to short timber, and to decay and butt rot caused by fire.

In May 1947 a heavy wet snowfall severely damaged the timber stand on the experimental forest. Salvage plans were developed, and late in the year operations to salvage the storm-damaged, defective, decadent, and cull or low-quality trees were started. Over the next four to six years this operation will be extended to most of the 1,520 timbered acres. The forest is being divided into temporary operable units for salvage purposes. Records of costs and returns, and volume cut by products will be kept in order to indicate the costs of cleaning up and rehabilitating unmanaged stands.

The 350 acres of cleared land will be planted eventually to trees for experimental and timber production purposes. During the year a plan

was prepared for planting about 18 acres in the spring of 1948. On this planting a commercial tree planting machine will be tested under field conditions common in Iowa and adjacent areas. The plantation will be used subsequently for management studies.

Early in the year personnel of the Ames Branch and the Conservation Commission made a cruise of the Farmington Unit of the Lee-Van Buren State Forest. Maps were made showing culture, plantations, drainage, forest types, and condition classes. A similar reconnaissance was made on the thousand-acre tract in the Lucas-Monroe State Forest. These surveys are being used as a basis for planning the research work to be undertaken on these areas.

In advance of planned cutting operations on the experimental areas, a master plan of cost keeping was drawn up. These records will show costs in man-hours, machine-hours, and current dollars, by such operations as thinning and harvesting, and by the various job components of each operation. A record of products obtained by kind for each operation will provide the quantities against which the costs were accrued. A record of sales prices will complete the data needed for determination of profit or loss. All agencies concerned will have access to the data.

Members of the Ames Branch and Forest Utilization Service personnel of the Columbus office and the Forest Products Laboratory made visits to several manufacturing and wood-using concerns in Iowa to discuss their wood requirements and their wood procurement problems. The possibilities of drawing further on native species and local sources were discussed.

During the period January through May 1947 the Ames Branch assisted the Columbus office in a survey to determine production and supplies of forest products at the sawmills in Iowa, Nebraska and Kansas. Lumber production in Iowa for the four-month period, January through April 1947, was 23.6 percent more than production during the same period in 1946.

The spring of 1947 broke many rainfall and climatic records in Iowa. It brought excessive moisture; lingering, low unseasonal temperatures; four inches or more of snow on May 29 in the northern and northeastern parts of the state; and then torrential rains and floods in June. The Ames Branch cooperated with the Regional Forester's office, Milwaukee, Wisconsin, in a reconnaissance to judge the effect of the national forest purchase units in Iowa on the severity of the floods of June 1947. The Regional Forester prepared a report on the reconnaissance.

Plans for 1948

Completion of the problem analysis and research program for this province will be emphasized in 1948. Upon its completion a meeting of the Ames Branch Advisory Council will be called. This group will be asked for suggestions to increase the effectiveness of proposed projects in meeting the needs of the province for research results.

Plans will be drawn up for an economic study of plantations that are of merchantable or near-merchantable size. Cost of growing the timber will be compared with expected value of the products. Pine and other coniferous plantations will be given first priority.

Salvage cuttings on the Paint Creek Experimental Forest will be made. The primary objective will be to rehabilitate the stands and to secure records on the cost of the operations. These cuttings will remove dead trees and trees that are not likely to live as long as five years. The cut trees will be processed through the Conservation Commission sawmill, which will be moved to the headquarters site early in 1948. Woods and mill cull will be determined in connection with the salvage cuttings. Logs in trees marked for felling will be graded, and bark thickness and form class data will be collected.

A management plan for the Paint Creek farm forestry demonstration tract will be prepared, and the initial cut is planned for late summer or early fall. A public demonstration will be scheduled as soon as the area has been logged and the products assembled.

About 18 acres on the Paint Creek Experimental Forest will be planted to conifers with a commercial tree planting machine. Both conifers and broadleaf species will be underplanted in hardwood stands to determine survival and growth rates.

The headquarters area will be improved with the increase in activities centering there. Roads will be laid out and surfaced with rock after completion of the landscaping plan and installation of the sawmill. Electricity on an R.E.A. line will be extended for a quarter-mile to the headquarters, and a telephone will be installed.

About 8 miles of fence will be built on the experimental forest--one-half by the Conservation Commission and one-half by adjacent landowners. Fence posts will come from current cuttings and where possible wire will be salvaged from interior fences that are to be removed. Tops and limbs and small trees that can be used for fence posts will be given peeling and preservative treatments. Methods of peeling and treating will be tested and demonstrated, and the costs and returns will be determined.

The Farmington State Forest will be examined to locate areas suitable for the study of optimum stocking of even-aged oak-hickory stands. Since most of the stands are 20-25 years old, other age classes must be found. After an adequate distribution of age classes for the study is assured, a work plan will be prepared.

The possibilities of growing conifers for Christmas trees will be studied on the Farmington area. In connection with these studies a demonstration is planned on state forest lands planted to conifers in 1938 and 1939.

Pruning experiments in conifer plantations established on the Farmington State Forest by the Civilian Conservation Corps will be designed and undertaken in cooperation with the Conservation Commission.

Additional contacts will be made with the Amana Society to complete plans for use of its timberlands for research purposes. The establishment of a farm forestry demonstration tract in the Amana woods will be explored further.

Timber growing and related problems in Illinois and areas in adjacent states with comparable problems are to receive major emphasis in the province of this branch station. At the outset, at least, much of the research center work is being concentrated on the Kaskaskia Experimental Forest. This area was purchased and developed during the C.C.C. days for the purpose of studying the forest problems of the Ozark uplift section of southern Illinois. It is located in Hardin County, near Elizabethtown and has a gross area of 7,040 acres, of which 1,684 acres are now federally owned. During the war years little research was possible and the physical improvements could not be maintained. Establishment of the Carbondale Research Center has made possible the reactivation of this unit.

Progress and accomplishments in 1947

During the past year progress has been made in preparing the experimental forest for a well-rounded research program. A complete road plan has been developed. The locations of first-priority roads have been established and construction will begin early in 1948. The buildings were wired for electricity, and R.E.A. lines were extended to them. Boundary lines were resurveyed and marked, and base maps are now in preparation. A grid of base lines to be used in establishing experimental plots and compartments has been laid out on the ground with identifying posts and markers spaced at frequent intervals. A complete sign system for the forest was developed and a part of the signs may be erected in the next year. A soils survey was completed and soils maps are now being made.

A study of current growth was initiated, and field work completed. The growth rate of the two major forest types, mixed hardwoods and oak-hickory will be used as a partial basis for establishing an allowable cut and length of cutting cycle for forest management studies now underway or to be initiated next year. Current growth will also serve as a reference point for comparisons of growth before and after treatment by the several management systems.

Overall cooperative agreements between the Central States Forest Experiment Station, the University of Illinois, and the Illinois State Division of Forestry were negotiated and placed in effect in 1947. Additional agreements are being worked out with private industry and should be completed next year.

A study of the relative wilting coefficients and rates of soil moisture depletion by tree seedlings and grass was summarized for publication. A popular article dealing with land-use problems was prepared for publication in a local periodical. It emphasized the place of forestry in the southern Illinois land-use pattern.

Much of the essential planning, so important in the initial period of organizing a new research center, was completed. In May 1947 representatives from the Division of Research, Washington office of the Forest

Service, the Central States Forest Experiment Station, and the Ames Branch Station met at Carbondale to discuss and develop a research program for the Carbondale Branch. The program evolved at this conference, with supporting data and background material, was incorporated in a preliminary program analysis. The analysis was completed in October.

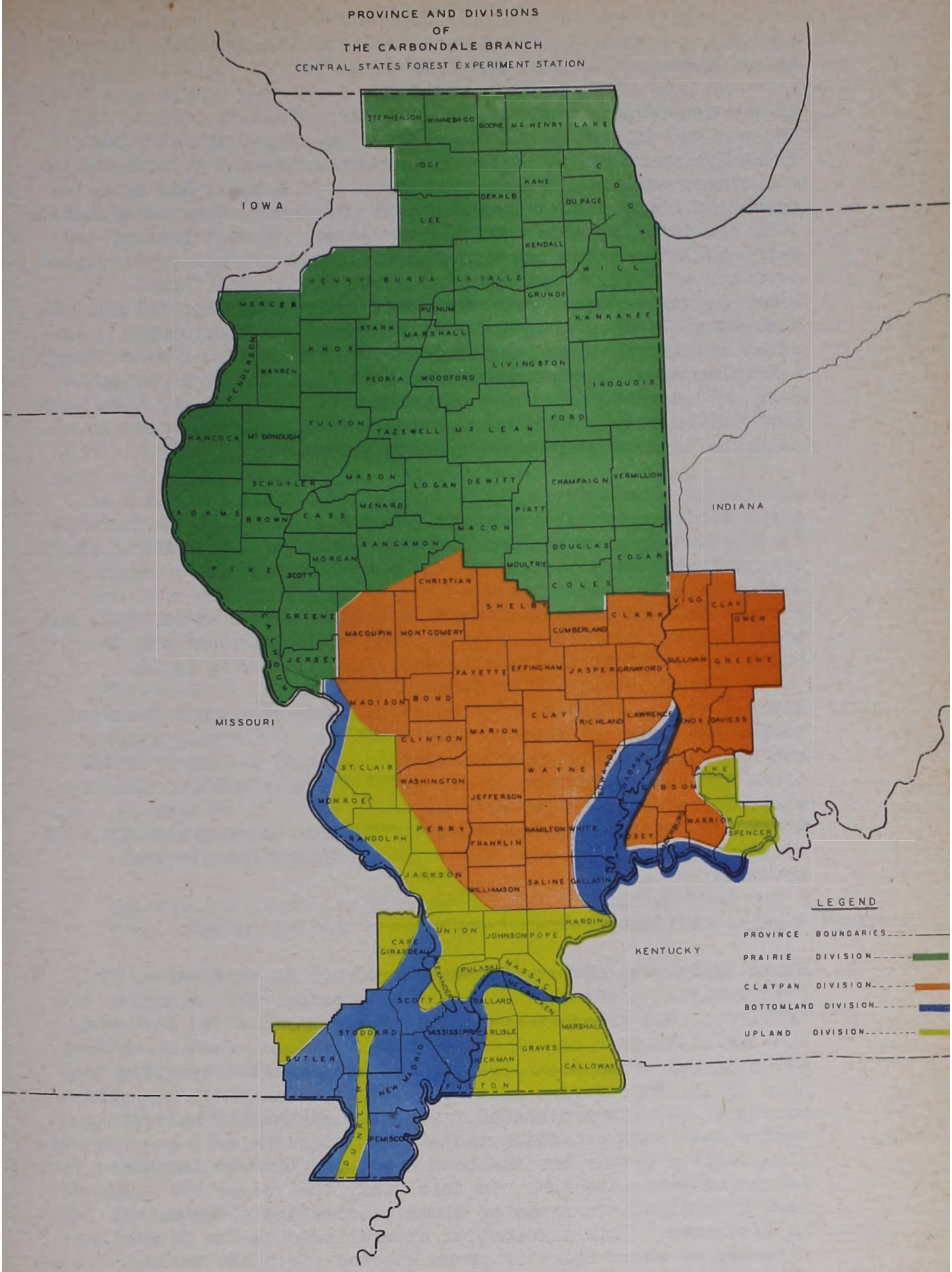
An advisory council was organized. It is composed of representatives of federal, state, and private agencies in the work center province that have forestry programs or interests, and of representatives of timberland owners and primary and secondary forest industries. The council reviewed the preliminary program analysis, and at its first meeting unanimously approved the recommended research program.

The province of the Carbondale Research Center is shown in Figure 6. In order to see clearly the nature of the research problems, the province has been split into the four divisions shown. These were rated in importance on the basis of the following factors: (1) extent and condition of present and potential forest lands, (2) present and anticipated land-use trends, (3) present and potential contribution of forestry to the local economy, (4) socio-economic conditions (5) forestry work of other agencies, and (6) previous policy decisions and commitments. Because the present research center personnel is unable to attack even the most pressing forest problems simultaneously and on the same scale throughout the area, work priorities were established. For the next few years, the research efforts of the Carbondale Research Center should probably be divided as follows: Prairie Division, none; Bottomland Division, 20 percent; Claypan Division, 30 percent; and Upland Division, 50 percent. During the present period of organizations, when time and effort are required to initiate studies on the Kaskaskia Experimental Forest, perhaps 75 percent or more of the research activities will be concentrated in the Upland Division. Later emphasis can be shifted more nearly to meet the goals given above.

In accordance with the program developed during 1947 the following demonstrations have been established in the Upland Division of the province:

1. Cutting practices. Three areas ofabout five acres each have been laid out in the mixed hardwoods type, and three areas of about $1\frac{1}{2}$ acres each in the oak-hickory type. One area in each type will be marked and cut according to good forestry practices, another according to moderate forestry practices (Minimum Cutting Practice Rules, Forest Service, Region 9) and the third according to poor forestry practies. These demonstrations are of the "show-window" type and will illustrate on the ground good, moderate, and poor marking and cutting practices in the two major forest types of the Upland Division.

2. Species adaptation to site. Two rectangular blocks, each containing $1\frac{1}{4}$ acres, were selected for planting. One block was established on an average old-field site, the other on a poor, eroded old-field site. Four species of conifers and three species of hardwoods were planted in each of the blocks. These demonstrations will provide easy, visual comparison of the


PROVINCE AND DIVISIONS
OF
THE CARBONDALE BRANCH
CENTRAL STATES FOREST EXPERIMENT STATION
IOWA
MISSOURI
INDIANA
KENTUCKY
STEPHENSON
WINNEBAGO
BOONE
MC HENRY
LAKE
DEKALB
DU PAGE
KENDALL
LEE
HENRY
BUREAU
LA SALLE
GRUNDY
WILL
KANKAKEE
MERCER
PUTNAM
STARK
MARSHALL
KNOX
HENDERSON
WARREN
PEORIA
WOODFORD
LIVINGSTON
IROQUOIS
FULTON
TAZEWELL
MC LEAN
FORD
HANCOCK
MC DONOUGH
SCHUYLER
MASON
LOGAN
DEWITT
CHAMPAIGN
VERMILLION
ADAMS
BROWN
CASS
MENARD
PIATT
MACON
SANGAMON
DOUGLAS
EDGAR
PIKE
MORGAN
SCOTT
MOULTRIE
COLES
CHRISTIAN
SHELBY
CLARK
VIGO
CLAY
OWEN
GREENE
MACOUPIN
MONTGOMERY
CUMBERLAND
JERSEY
FAYETTE
EFFINGHAM
JASPER
CRAWFORD
SULLIVAN
GREENE
MADISON
BOND
CLAY
RICHLAND
LAWRENCE
KNOX
DAVIESS
CLINTON
MARION
ST. CLAIR
WASHINGTON
WAYNE
PIKE
GIBSON
MONROE
JEFFERSON
PERRY
HAMILTON
WHITE
POSEY
WARRICK
SPENCER
RANDOLPH
FRANKLIN
JACKSON
WILLIAMSON
SALINE
GALLATIN
HARDIN
UNION
JOHNSON
POPE
CAPE GIRARDEAU
PULASKI
MASSAC
ALEXANDER
SCOTT
BALLARD
MCCRACKEN
STODDARD
MISSISSIPPI
CARLISLE
MARSHALL
BUTLER
GRAVES
HICKMAN
CALLOWAY
NEW MADRID
FULTON
DUNKLIN
PEMISCOT
LEGEND
PROVINCE BOUNDARIES
PRAIRIE DIVISION
CLAYPAN DIVISION
BOTTOMLAND DIVISION
UPLAND DIVISION

survival and growth of species usually recommended for planting on two common sites in the Upland Division.

3. Farm woodland management. Approximately three-fourths of the forest land in the Upland Division is in small farm woodlands. Probably less than one farmer in twenty manages his woodland in conformity with good forestry principles. Very little stand improvement work, such as thinning, pruning, and other intermediate cuttings is being done on these woodlands. Almost half of the farm woodlands are being grazed and practically all of them show evidence of fire. Furthermore, only a few of the farmers or other private owners realize that if given proper protection and management, their forests will yield a perpetual crop and a constant return. A tract of about 25 acres of good hardwood timber was selected to demonstrate the income that can be expected of farm woodlands under good management. We shall manage this woodland intensively, using the best forestry practices known to obtain the highest possible sustained income.

4. Rebuilding a badly deteriorated farm woodland. Thousands of acres of farm woodlands in the Upland Division have been seriously depleted by overcutting, grazing, and fire. A stand of about twenty-five acres, typical of these woodlands was set aside to demonstrate the methods needed and to determine the cost and returns in rebuilding this type of woodland. We shall apply the best forestry practices known to this tract in an effort to rebuild the stand to its maximum sustained producing level.

5. Natural area. A block of about eight acres of virgin hardwood timber has been set aside. This tract is fairly well stocked and has a reasonably good diameter distribution. Many of the trees are now overmature or are approaching maturity. The area will be preserved in its natural state and will be used to illustrate the mature hardwood forest as well as demonstrate the loss of growth and income resulting from holding timber beyond maturity.

esearch studies initiated during 1947 include the following:

1. Stand objectives for the management of upland hardwoods. This observational study should show the stocking, tree diameter distribution, and growth for the better unmanaged mixed hardwoods and oak-hickory stands of the Upland Division. Farm foresters and managers of national and state forests need a specific picture of an ideal forest as a goal toward which their management practices should be directed. Observations on the better unmanaged stands will provide a tentative goal which will have to suffice until a better one has been developed through long-time forest management research. In this study the volume and grade of logs and billets in trees of given species and diameter will also be estimated. This information should indicate the approximate diameter at which trees of given species yield the maximum financial return.

. Management of the mixed hardwoods and oak-hickory types. Probably the highest priority work in the province of the Carbondale Research Center is to determine how to manage existing hardwood stands for their maximum sustained production and financial return. Foresters and timberland owners urgently need the answers to such questions as: What are the relative merits of even-aged and all-aged management? What is the most profitable rotation and cutting cycle for the various types and sites? Will money spent today for stand improvement yield a profit in the future? What is the optimum volume and tree diameter distribution at various ages for the different sites and types?

During the past year 36 compartments were surveyed and permanently marked on the Kaskaskia Experimental Forest. Eighteen were established in the oak-hickory type and 18 in the mixed hardwoods type. The compartments average about 20 acres each and will be used for experimental management studies. The stands of timber to be produced in the several compartments should show what the various management systems can accomplish. The record book will tell the financial story.

Each of six different systems for managing the mixed hardwoods type will be tested on three compartments. The systems are as follows:

1. Even-aged intensive management using a two-cut shelterwood system with a long rotation.

2. Uneven-aged intensive management with a short rotation and a short cutting cycle.

3. Uneven-aged intensive management with a short rotation and a long cutting cycle.

4. Uneven-aged intensive management with a long rotation and a short cutting cycle.

5. Uneven-aged intensive management with a long rotation and a long cutting cycle.

6. Uneven-aged extensive management with a long rotation and a short cutting cycle.

Each of the nine systems for managing the oak-hickory type will be tested on two compartments. The systems are as follows:

1. Even-aged intensive management using a commercial clear cutting on a short rotation plus interplanting with pine and cedar.

2. Even-aged extensive management using a commercial clear cutting on a short rotation.

3. Uneven-aged intensive management using a long rotation and short cutting cycle plus interplanting with pine and cedar.

4. Uneven-aged intensive management using a long rotation and a short cutting cycle without interplanting.

5. Uneven-aged intensive management using a long rotation and a long cutting cycle plus interplanting with pine and cedar.

6. Uneven-aged intensive management using a long rotation and a long cutting cycle without interplanting.

7. Uneven-aged intensive management using a short rotation and a short cutting cycle.

8. Uneven-aged extensive management using a long rotation and short cutting cycle.

9. Uneven-aged extensive management using a short rotation and a long cutting cycle.

3. Direct seeding of pine and eastern redcedar. In the Upland Division of the province are about 1.5 million acres of submarginal agricultural land. In the foreseeable future much of this area probably will be planted to forest or revert naturally. The objective of this study is to determine if pine and redcedar plantations can be established by direct seeding and if so, at what cost. During 1947 plots were laid out on several sites on the experimental forest and on the Shawnee National Forest. On some plots loblolly and shortleaf pine and redcedar were established by direct fall seeding. On the remaining plots these species will be similarly seeded in the spring of 1948. The survival and growth of these plantations will be compared with the success of others established by planting seedlings of these species.

4. Fall vs. spring planting. The survival and growth plantations established in the fall will be compared with others established in the spring. Plots were laid out on several sites on the experimental forest and on the Shawnee National Forest. Some of these were planted in the fall of 1947. The remainder will be planted in the spring of 1948. If plantations can be established successfully by fall planting on some sites, the spring work load at the nursery and at the planting site can be reduced, and the period for planting can be extended. Thus an expanded planting program can be undertaken without materially increasing the size of crew or facilities.

5. Cumulative volume tally sheets. Farm foresters and others throughout the Research Center province are now using cumulative volume tally sheets developed to fit timber stands in other regions. Tests indicate that the volumes on which these tally sheets are based should be revised to apply to local timber stands. A study was initiated in 1947 aimed at determining

corrections needed to give more accurate volumes and how these corrections can be applied. The Illinois Technical Forestry Association is cooperating with the Carbondale Branch on this work.

Plans for 1948

In 1948 a few necessary planning and improvement jobs, such as developing a permanent record system for experimental timber management studies, preparing a descriptive folder for the experimental forest, and developing plans for additional buildings needed to store equipment will be undertaken. Most of the improvement work started this past year will be completed before the end of 1948.

An initial cut will be made on the cutting practice demonstration areas, the two farm woodlands, and several of the compartments. The stand objective study, field work on the two planting studies, and the cooperative work on cumulative volume tally sheets will also be completed.

Additional demonstrations will be confined to the Upland Division, and will be located on the Kaskaskia Experimental Forest and on the Shawnee National Forest. They will demonstrate planting methods, development of shipmast and common black locust plantations, effect of ground cover on the survival and growth of planted hardwood seedlings, and the results of pruning shortleaf and pitch pine plantations. All but the first of these will make use of experimental plots established a few years ago.

Formal studies planned for the Upland Division in 1948 include:

1. Completion of earlier studies. The studies initiated on the Kaskaskia Experimental Forest prior to establishment of the Carbondale Branch are now ready for final measurement or progress reports. Members of the Research Center staff and the Forest Management Division reviewed these earlier studies on the ground, and laid plans for their future disposition. Four of the principal studies are:

    a. Pruning of shortleaf and pitch pine plantations.

    b. Effect of ground cover on survival and growth of planted hardwood seedlings.

    c. Relative development of shipmast and common black locust plantations.

    d. Relationship between types of tree defects and associated cull.

    These studies will be brought up to date and formal releases made where warranted.

2. Forest Management Unit. A block of timber having approximately 400 acres has been selected for management on the experimental forest. This will be the final testing ground for the results of plot and compartment studies. During the next year this unit will be surveyed and permanent boundary markers set up, an inventory will be made, a management plan prepared, and if time permits, an initial improvement cut will be made.

3. Forest Service Minimum Cutting Practice Rules. A few years ago Forest Service offices in Region 9 developed a set of cutting practice rules for the major types of the region. One compartment of about 20 acres on the experimental forest will be set aside in the mixed hardwoods type and another in the oak-hickory type. These will be marked and cut in accordance with these rules and will provide a test of the suggested minimum cutting practices.

4. Seed source of pine and cedar. Studies in the South and elsewhere have indicated that seed source may have a significant bearing upon the survival and growth of tree seedlings planted in a given locality. Seedlings will be grown from seed of shortleaf and loblolly pine and eastern redcedar obtained from several widely scattered sources. These will then be planted on several sites in an attempt to determine which of these sources will provide the best planting stock for use in the Upland Division.

5. Interplanting of oak-hickory stands with shortleaf pine and eastern redcedar. By interplanting the poorer oak-hickory forests with pine and cedar we may be able to increase the yield of these stands. Before undertaking wide-scale interplanting, as previously outlined for the compartments, we propose to explore the effect of time and intensity of release upon survival and growth of the interplanted trees. This study is directed toward the biological aspects of interplanting rather than the economic. Several valuable leads are available from the study of this problem in the Missouri Ozarks.

6. Plantation management. During the past quarter-century several thousand acres of plantations have been established in the Upland Division. The Shawnee National Forest alone has approximately 25,000 acres of plantations. Most of this area was planted with shortleaf and loblolly pine and redcedar. Due to overstocking some of the earlier plantations are showing signs of stagnation and should be thinned. Within the next few years several thousand acres will need thinning if satisfactory growth is to be maintained. Furthermore, many of these young stands are now ready for pruning. Thinning and pruning studies designed to answer questions on some of the cultural aspects of plantation management are planned for 1948.

7. Utilization. Modern equipment will be used and demonstrated in felling, bucking, skidding, loading, and hauling the products harvested under the various management systems used on the experimental forest. Time, cost, and performance data will be

taken on the various pieces of equipment to be used in the cutting planned for next year.

8. Christmas tree production on spoil banks. The objective of this study is to study and demonstrate the survival, growth, and costs and returns of producing Christmas trees on spoil banks resulting from strip mining. Four species of coniferous seedlings will be used. They are Scotch, red, and jack pines, and eastern redcedar. Four acres of spoils, one for each species, will be planted each year for six consecutive years. This study will be undertaken jointly by the Illinois Central Railroad, the Illinois Coal Strippers' Association, the United Electric Coal Company, and the Carbondale Branch.

OHIO PROJECT

Progress and accomplishments in 1947

During the spring of 1947 field work on the study of maple syrup production undertaken by the Ohio Agricultural Experiment Station was completed. Owing to the loss of personnel engaged on this project, analysis of field data was not completed. Certain broad generalizations, however, can be made.

An adequate stand of sugar maple trees is the most important factor in maintaining a profitable sugar bush. The long-time decline of syrup production in northeastern Ohio is directly associated with present practices in woodland management. Some sugar bushes have been clear cut for their timber. Others have been so heavily grazed that natural restocking has not replaced the thinning stand of mature maples. Some forty to sixty years are necessary for a sugar maple to reach a diameter of ten inches at breast height, the minimum satisfactory tappable size. Thereafter, a tree can be tapped annually throughout its life, which may extend over a period of two hundred years or more.

The sugar content of maple sap varies with the season, the day, site, individual tree, and even differs on different sides of the same tree. It is possible that further study of site factors and tree characteristics associated with sweetness of sap may increase substantially the efficiency of maple sugar production. Testing of individual young maples for sweetness of sap and developing a successful method of propagation of high yielding trees may develop a strain of sugar maple having sap of superior sweetness. Table 7 shows the range of sweetness of sap in representative sugar bushes and indicates that the average cost per gallon of syrup declines sharply with an increase in sweetness.

Table 7.--Cost of producing maple syrup from sap of varying degrees of sweetness, northeastern Ohio, 1947

Sweetness class	Average cost per gallon	Syrup produced per 100 buckets hung	Basis
Gallons of syrup per 100 gallons of sap	Dollars	Gallons	No. of bushes
Less than 1.50	4.30	13.00	1
1.50 to 1.74	3.10	18.62	1
1.75 to 1.99	2.82	24.64	5
2.00 to 2.24	2.69	24.89	5
2.25 to 2.49	2.53	22.77	23
2.50 to 2.74	2.49	21.86	5
2.75 or more	2.00	29.45	9
Average or total	2.50	24.21	49

Plans for 1948

The Agricultural Experiment Station plans to assign one or more men to complete the analysis on this project and to prepare the report for publication during 1948.

IOWA PROJECT

Progress and accomplishments in 1947

The Ames Branch assumed responsibility for analyzing the lumber grade yield data taken by Prof. George B. Hartman of the Forestry Section, Iowa Agricultural Experiment Station from 1943 to 1945 and for preparing the results of the study for publication.

Analysis of the data on white elm, eastern cottonwood, and northern red oak logs has provided information on lumber grade yields for these three species in Iowa. In 1942 nearly 50 percent of Iowa's lumber production was from these species. For each species, the following kinds of information are now available: (1) grade yield of lumber by log grade; (2) grade yield of lumber by log size within log grade; (3) grade yield of lumber disregarding log grade and log size; and (4) grade yield of lumber by log size disregarding log grade.

Without modification, the northern hardwood log grades do not appear to be entirely satisfactory for general use on Iowa timber. By definition grade 1 logs should yield 60 percent or more No. 1 Common and better lumber, grade 2 logs should yield 25 to 59 percent, and grade 3 logs should yield 24 percent or less. In the Iowa study white elm logs less than 21 inches in diameter classified as grade 1 failed to yield the minimum requirements of No. 1 Common and better lumber. Similarly, grade 2 elm logs in the 10-inch diameter class failed to yield 25 to 59 percent No. 1 Common and better lumber. Grade 3 logs gave the required yields. For cottonwood the study indicates that under Iowa conditions the minimum-sized log for grade 1 should be raised to 17 inches. The grade 2 and grade 3 logs gave the required yields. For northern red oak, the rules were found to fit satisfactorily.

Defects recognized in the grade-yield study included sweep, shake, and rot. The total deduction for these three classes of defect was 5.3 percent for white elm, 3.0 percent for cottonwood, and 2.5 percent for northern red oak. For all three species combined, deductions accounted for 3.6 percent of the gross volume of the logs. Grade 1 logs contained 2.7 percent defect; grade 2 logs, 3.6 percent; and grade 3 logs, 5.0 percent.

Overrun and underrun of the logs was determined using the Doyle, Scribner Decimal C, and the International 1/4-inch log rules. In this determination only logs free of cull were used. As is indicated below, all three log rules overran on small logs and underran on large ones. In this respect this study partly checks the grade-yield study made in Indiana.

International 1/4-inch rule:	Gave overrun on logs smaller than 14 inches and underrun on large logs, leveling off at 22 inches with approximately 5.0 percent underrun.
Scribner Decimal C rule:	Gave overrun on logs smaller than 20 inches and underrun on large logs, leveling off at 33 inches with approximately 10.0 percent underrun.
Doyle rule:	Gave overrun on logs smaller than 23 inches and underrun on large logs, reaching 9.0 percent underrun at 29 inches and 18.0 percent underrun at 35 inches.

Plans for 1948

An outline and a manuscript will be prepared for review by the Forestry Section, Iowa Agricultural Experiment Station, and by the Central States Forest Experiment Station. A preliminary report on the findings of this study is planned for release early in 1948. Initial plans for the preliminary report call for a Station Note to be issued by the Central States office and a semipopular release in Iowa Farm Science, a publication of the Iowa Agricultural Experiment Station.

ILLINOIS PROJECT

Progress and accomplishments in 1947

During 1947 a cooperative study of the veneer box and basket industry in Illinois was undertaken in cooperation with the Illinois Agricultural Experiment Station. The objective of this study is to determine the supply of raw material available to this industry, its annual requirement for wood, its productive capacity, the degree to which it is meeting the Illinois demand for veneer boxes and baskets, and the possibilities for future expansion in the light of the Illinois forest resources and the demands of other industries upon them.

Plans for 1948

Initial plans for the study contemplate its completion by June 30, 1948.

PERSONNEL

(December 31, 1947)

ADMINISTRATION

HAROLD L. MITCHELL, Director; Jean R. Donahue, Secretary

HERBERT C. BRADSHAW, Administrative Assistant; Mary J. Prater, Mary L. Posey, Laura C. Sisk, Josephine Stauder, Wendell L. Dickinson, Bertha G. Bartram, Leona B. Kale, J. Kenneth Vaughn.

ECONOMICS DIVISION

ROBERT K. WINTERS, Chief; Virginia K. Tomlinson, Secretary, Alberta M. Hiatt

Survey Inventory -- Eugene V. Roberts

Field Project -- Maxwell E. Becker, August E. Block, Theodore J. Schmitt, John E. Wiggins, Jr.

Photo Interpretation -- Karl E. Moessner, O. Keith Hutchison, Kenneth L. Quigley, Karl W. Chrisemer

Growth and Statistical Procedures -- G. Luther Schnur

Commodity Drain -- _____

Computing -- Lake F. Compton, Margaret K. Peirsol, Mary L. Sterner

Forest Resources Analysis -- David B. King

Economics of Management and Utilization -- Robert K. Winters, James T. Morgan

FOREST MANAGEMENT DIVISION

ARTHUR G. CHAPMAN, Chief; Jeanne F. Cowden, Secretary

Soils -- John T. Auten

Mensuration -- G. Luther Schnur

Silviculture -- Franklin G. Liming, Gustaf A. Limstrom

Spoil Bank Reclamation

Carbondale Field Headquarters _____
Post Office Building
Carbondale, Illinois

Pittsburg Field Headquarters — Nelson F. Rogers
Room 213, Music Building
Kansas State Teachers College
Pittsburg, Kansas

Buffalo Field Headquarters — Robert W. Merz
Buffalo, Ohio

FOREST UTILIZATION SERVICE

_____, Chief

Primary Industries -- Ralph K. Day

Secondary Industries -- Marsden R. Brundage

BRANCH STATIONS

CARBONDALE BRANCH -- Richard D. Lane, Leon S. Minckler, Cleo Caraway
Post Office Building
Carbondale, Illinois

Kaskaskia Experimental Forest -- Donald L. Fassnacht, Robert K. Train
Elizabethtown, Illinois

AMES BRANCH -- E. Garth Champagne, Leonard F. Kellogg, John E. Krajicek, Barbara L. Ward
c/o Forestry Department
Iowa State College
Ames, Iowa

Paint Creek Experimental Forest -- Franklin R. Longwood
McGregor, Iowa

COOPERATIVE FARM FORESTRY RESEARCH

OHIO PROJECT -- O. D. Diller

IOWA PROJECT -- G. B. Hartman

ILLINOIS PROJECT -- C. S. Walters

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